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I. Introduction

It is 10:30 am. You had a granola bar at 7:30 am before leaving for work, but your stomach is already grumbling. You normally have a larger breakfast, but you were in a hurry this morning. Fortunately, you remember you still have your yogurt in the office refrigerator from yesterday, so you'll have that with a handful of berries. How would you describe this situation? Was the yogurt and fruit a continuation of your breakfast, or would you consider it a snack? What if you had the yogurt and fruit as soon as you got to work at 8:00 am? Does this change your classification?

There is no obvious consensus answer to these questions because interpretations of the situation will vary from individual to individual. Similarly, researchers have differing ideas about what constitutes a snack or snacking occasion, and these differences are reflected in their research. A wide body of snacking research exists, with topics ranging from the cognitive and behavioral factors that influence snacking to the relationship between snacking and obesity among Americans. However, there are currently no standardized definitions for the terms "snack" and "snacking occasion," which makes it difficult to compare study results. Research is most meaningful when studies can be compared, and the best comparisons are between studies that have as many common features. Consistency among snacking research studies is critical to provide the strongest evidence on the relationships between snacking and health outcomes. The purpose of this paper is to highlight the need for collaboration and research to determine standardized definitions of "snack" and "snacking occasion" and to bring the issue to the attention of academics, consumer research groups, governing agencies and professional groups that focus on health and nutrition issues, and the food industry.

Defining the terms "snack" and "snacking occasion" is not a simple task, and there is no simple solution. Here, I propose some methods for working towards standardized definitions for "snack" and "snacking occasion." Additional consumer research would help identify commonly agreed upon characteristics of snacking from a consumer perspective. Focus groups that bring together stakeholders (academics, consumer research groups, governing and professional agencies, and food industries) would create opportunities to discuss and determine one or more agreed upon definition(s) of "snack" and "snacking occasion."

These are only the first steps in a long process to better understand snacking associations and ultimately the relationships between snacking and health outcomes. Once standard definitions are developed, additional scientific research can be conducted. Professional, academic, and government institutions can then create more effective guidelines for healthy eating. Finally, governing agencies and the food industry can work in conjunction with one another, using the guidelines to develop policies and produce retail options that help Americans work attain healthy eating goals.

Society is overwhelmed with information and options, and when it comes to understanding snacking, it will take clarification of the terms for consumption occasions to fully grasp the influence of consumption patterns and behaviors on our health.

II. Background and History

Starting from Square One

The eating patterns and habits of Americans have changed drastically over time. Changes in meal frequency and occasions are related to a number of social, economic, and technological factors, including the increase in single person households, women in the workforce, and employment levels. These factors have led to a decline in traditional meal times due to less shopping time, less formal dining, and increased snacking and grazing (IGD Fact Sheet Healthy Snacking 2006).

In the early 20th century in the US, longer meal times and greater meal frequency were associated with higher social status. The wealthy, privileged classes ate as many as 5 times daily (breakfast, lunch, tea, dinner, supper), whereas the middle/industrial and agrarian/rural classes ate only 3 times daily (Olver 2000). The standard meal plan was three meals per day, or "three square meals," until World War II. The onset of the war meant more women entering the workforce. Being the primary grocery shoppers and cooks of the household at that time, women had less time to devote to planning and preparing meals. After the war ended, the feminist movement of the 1960s and 1970s empowered women to stay in the workforce instead of going back to a domestic lifestyle. Other changes included a shift from 3 meals per day to 2 meals per day with snacks, occurring between 1880 and 1980 (Fjellstrom 2004). Some argue the shift was related to the decrease in the workday from 12-14 hours to 8 hours, leaving less time for the mid-day meal (Fjellstrom 2004).

Meanwhile, technological advancements in food production and packaging relating to the industrial revolution and WWII, combined with the mass exodus of women from the kitchen created a new niche for the food industry. Commercial snack production began booming at the beginning of the 20th century, although some "snack" foods were invented as early as the 1830s (Ament 2007) and even earlier for popcorn (McCarthy 2000). The end of Prohibition in 1933 drove increased production of salty snacks to accompany drinks (McCarthy 2000). The potato chip industry was a pioneer in the snack foods movement, successfully convincing the government that potato chips were the most efficient, economical way to package and ship ready-to-eat potatoes (McCarthy 2000).

Since food had become so abundant and was easily accessible for most, cooking was not a necessary skill for survival. As a result, cooking skills declined. That, coupled with a growing demand for eating opportunities, including snacks, resulted in an increased consumption of food outside the home. One estimate indicates that consumption of food away from home grew from 18% in the 1970s to 32% in the 1990s (USDA 2001-2002).

The rise of the snack food industry was not without opposition. In the 1960s and 1970s, a heightened concern for Americans' eating habits and attacks on snack foods as "junk foods with little or no nutritional value" further challenged the snack food industry. This motivated the industry to focus on the nutritional benefits of snack foods and fueled a push for healthier, low-fat snack foods (McCarthy 2000). Public concern surrounding the healthfulness of snack foods continued into the following two decades, opening up more opportunities for fat-free and sodium-free products (McCarthy 2000). In 1990, Congress passed the Nutrition Labeling and Education Act to "encourage manufacturers to

improve the nutritional quality of their products" and to "help customers make healthier food choices" (The Prevention Institute 2002).

Snacking Today

Snacking is now common in American among both adults and children. Roughly 94% of Americans consume at least one snack per day (IFIC 2009), and the average daily snack intake is approximately 2.5 snacks per day (IFIC 2007-2008). According to another study, one in every five eating occasions is considered a snack (NPD Group Snacking in America 2012).

Both adult and adolescent snacking appear to have increased significantly over the past 30 years. Adult snacking rose from 59% to 90% between 1977-78 and 2007-08 and adolescent snacking rose from 61% to 83% between 1977-78 and 2005-06 (NHANES WWEIA) (Figure 1). Similarly, nationally representative food intake surveys show large increases in snacking among children between the 1989-91 to 1994-98 and 1994-98 to 2003-06 periods (Piernas and Popkin 2010) (Figure 2). Current research shows that children's snack intake has trended up to an average of 3 snacks per day, and the options they are choosing are increasingly more energy-dense (Piernas and Popkin 2010; 2010 Dietary Guidelines Advisory Committee Report). This has contributed to a greater total energy intake from snacks (2010 DGAC Part D, Section 1: Energy Balance, p.25). It is estimated that snacks now provide roughly a quarter of daily calories (22-27%) in all age groups (NHANES WWEIA; Popkin and Piernas 2010; Andersson et al 2003).

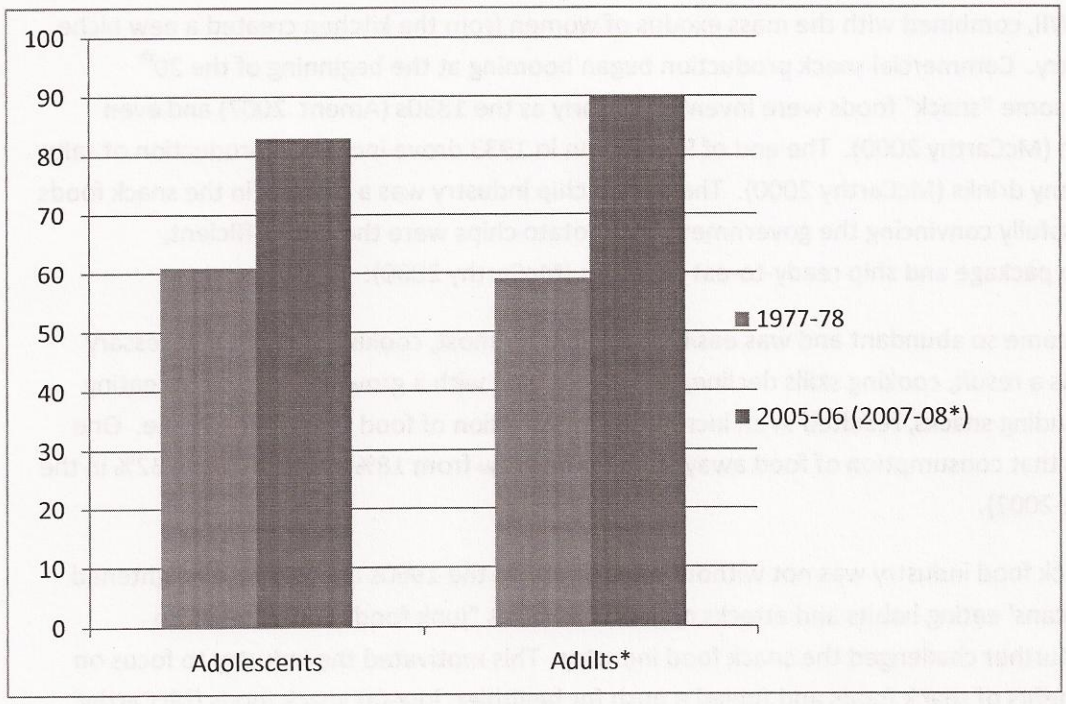

Figure 1. Percent Increase in Snacking Among Adolescents and Adults. Sources: NHANES What We Eat in America, 2005-06 (Adolescents); NHANES What We Eat in America, 2007-08 (Adults).

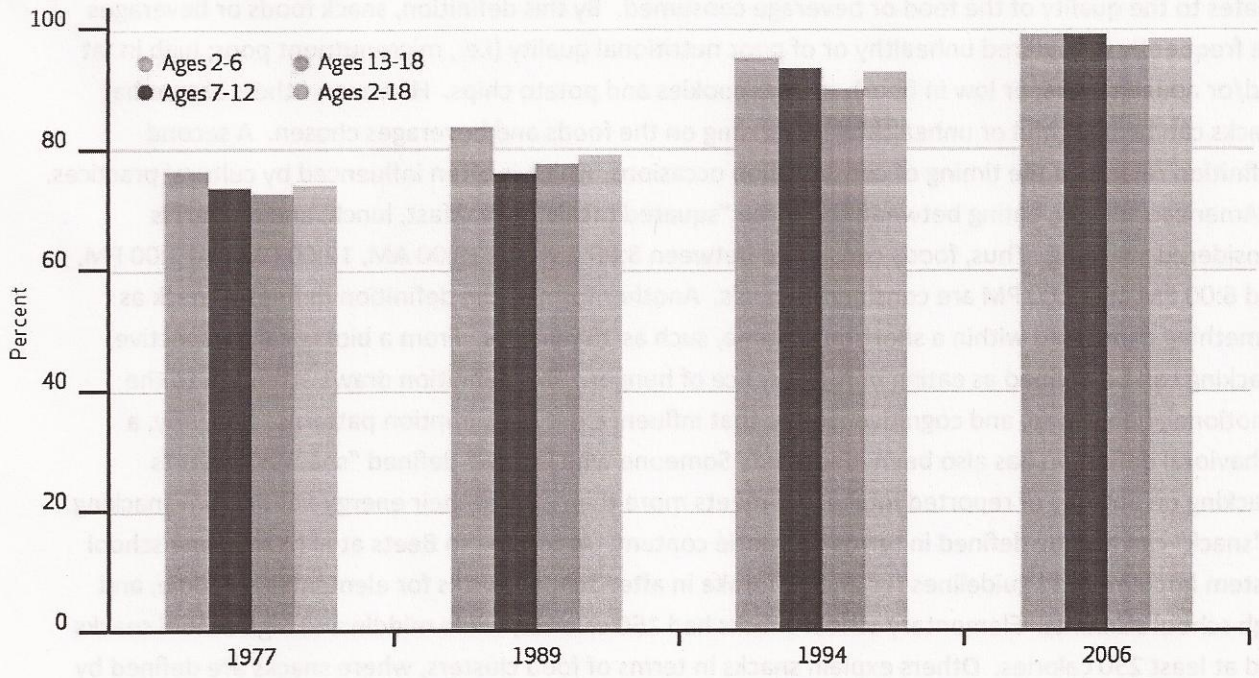

Figure 2. Percentage Of U.S. Children Consuming Snacks Over A Two-Day Period, Selected Years 1977–2006. Sources: Piernas C , Popkin B M Health Aff 2010;29:398-404; ©2010 by Project HOPE - The People-to-People Health Foundation, Inc.

Duffey and Popkin (2011) concluded that the 29% increase in eating times per day they observed between 1970 and 2000 was most likely contributing to an increase in calorie consumption. They noted that portion size of snacks only increased 12%, while energy density actually decreased. This evidence supports a link between greater snacking frequency and higher calorie consumption in Americans.

The research suggests that increased snacking is the culprit behind increasing calorie consumption in the US and subsequent national weight gain. But are snacks largely to blame for increased calorie intake? While consumers are eating more often, it is also important to consider how quality, quantity, timing, and behaviors surrounding food and beverage intake patterns are perceived. The boundaries between meals and snacks have become blurred, which raises the question of what is really meant by "snack" and "meal" when it comes to evaluating research.

III. The Problem

It is unlikely that any two people will give the same definition of a "snack," "meal," or any other consumption occasion term, and the lack of a clear, standard definition is reflected in the research. Several broad categories of "snack" definitions have been described by consumers and researchers (Gregori and Maffeis 2007; McCrory and Campbell 2011; Rodríguez and Moreno 2006; Jahns 2007, response to Gregori and Maffeis LTE; Johnson and Anderson 2010). Table 1 outline the various

definitions and show how each definition could be applied in the opening scenario. One definition relates to the quality of the food or beverage consumed. By this definition, snack foods or beverages are frequently considered unhealthy or of poor nutritional quality (i.e., micronutrient poor; high in fat and/or added sugars; or low in fiber), such as cookies and potato chips. However, others argue that snacks can be healthful or unhealthful depending on the foods and beverages chosen. A second definition relates to the timing of consumption occasions, which is often influenced by cultural practices. In American society, eating between the three "squared meals" (breakfast, lunch, and dinner) is considered snacking. Thus, foods consumed between 8:00 AM and 10:00 AM, 12:00 PM and 2:00 PM, and 6:00 PM and 8:00 PM are considered meals. Another form of the definition defines a snack as something consumed within a short time frame, such as 15 minutes. From a biological perspective, snacking can be defined as eating in the absence of hunger. This definition draws attention to the emotional, behavioral, and cognitive factors that influence our consumption patterns. Similarly, a behavioral definition has also been identified. Someone who is a self-defined "snacker" reports snacking on any day of reported intake and meets more than 20% of their energy needs from snacking. A "snack" can also be defined in terms of calorie content. According to Beets et al (2011), one school system implemented guidelines for energy intake in after-school snacks for elementary, middle, and high school students. Elementary school snacks had 150 calories, while middle and high school snacks had at least 250 calories. Others explain snacks in terms of food clusters, where snacks are defined by the amount of calories consumed over time. This definition combines timing and calorie intake, and is among the many hybrid definitions that exist to describe snacks and snacking. The Food-Based Classification of Eating Episodes (FBCE) categorizes eating events by providing data on the frequency, nutritional quality, and temporal distribution of eating events, representing different combinations of food categories on the basis of their key nutrients (Lennernas and Andersson 1999).

The food industry appears to have its own definitions of what constitutes a "snack" or "snacking occasion." Snack foods generally fall into two categories: savory/salty and sweet. Salty or savory snacks include chips, nuts, popcorn, beef jerky, pork rinds, potato sticks, trail mix, and pretzels (Agriculture and Agri-Food Canada; Gale Group 2002). Foods like crackers, baked sweet goods, candy, and cookies are generally identified as sweet snacks. Yet, many of these types of snacks can taste either sweet, salty, or a combination of both, such as with trail mix or kettle corn (Figure 3).

Definition Type	**Description**	**Example with Opening Scenario**
Quality	Snacks considered unhealthy /of poor nutritional quality (i.e., micronutrient poor; high in fat and/or added sugars; or low in fiber)	Healthy vs unhealthy; consider ingredients (sugar, saturated fat, etc)
Culture/ timing	Eating between regular meals (breakfast, lunch, and dinner) in American society; something consumed within a short time frame (i.e., 15 minutes)	Bar eaten at 7:30 am would be breakfast, yogurt at 10:30 am would be snack

Biological	Eating in the absence of hunger.	Hunger is the reason for eating
Behavior	Someone who is a self-defined "snacker" reports snacking on any day of reported intake and meets more than 20% of their energy needs from snacking.	Depends on how the eater describes the situation
Caloric	Defined in terms of calorie content.	Consider calories in bar vs yogurt with fruit
Food cluster	Defined by the amount of calories consumed over time	Consider calories, how long it took to eat
Hybrid	One example is the Food-Based Classification of Eating Episodes (FBCE) , which categorizes eating events by providing data on the frequency, nutritional quality, and temporal distribution of eating events.	Consider that there were 2 separate eating occasions, nutrients in each, 3 hrs between eating
Food industry	Salty or savory snacks include chips, nuts, popcorn, beef jerky, pork rinds, potato sticks, trail mix, and pretzels . Sweet snacks are often crackers, baked sweet goods, candy, and cookies.	Consider if the bar or yogurt with fruit fit into any of these categories

Table 1. Major Types of Snack Definitions. Sources: Gregori and Maffeis 2007; McCrory and Campbell 2011; Rodríguez and Moreno 2006; Jahns 2007, response to Gregori and Maffeis LTE; Johnson and Anderson 2010.

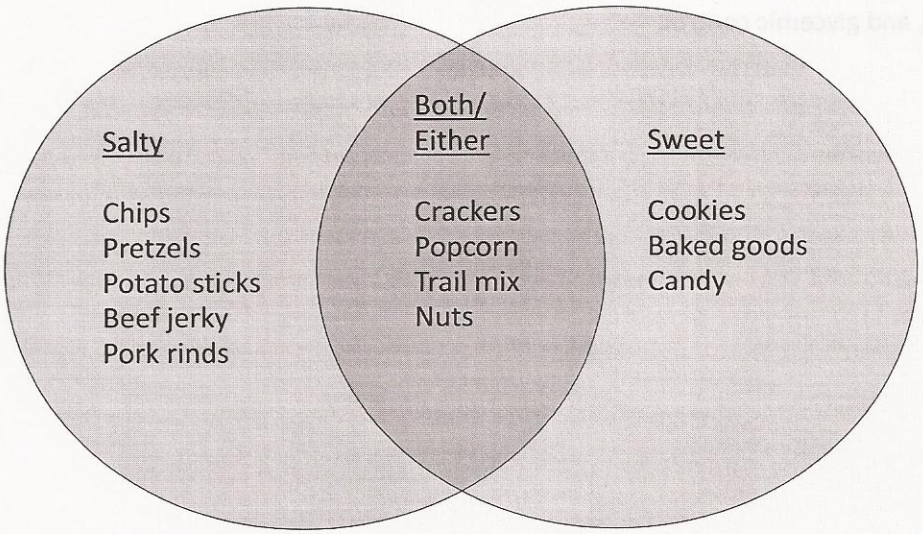

Figure 3. Food Industry Snacks. Sources: Agriculture and Agri-Food Canada; Gale Group 2002.

Additional issues arise when attempting to define snacking and can create further ambiguity when communicating research about snacking. Many studies use the language "eating frequency" synonymously with "snacking frequency" because of an implied correlation between the two terms. However, "eating frequency" could theoretically include meals or other eating occasions that would not be considered snacking. Beverages pose another dilemma. For example, several studies have included water as a snack, while others consider only beverages with calories as snacks. A number of studies exclude liquids altogether. Even defining "eating occasion" seems to be a challenge. One research study considered an "eating occasion" to be 50 calories separated from another eating episode by 15 minutes, but others employ more qualitative, less rigid terms such as main meal, beverage meal, light meal, or snack categories (AND Position Paper on Weight Management 2009).

How snacking is defined by researchers, consumers, the food industry, and other influential groups affects our ability to communicate about snacking as a society. Interpretation of the research is jeopardized because definitions are inconsistent across studies. The food industry defines snacks and snacking in a way that best meets their needs to provide products for consumers. The consumer is caught in the middle, trying to understand the science and responding to the options presented by the food industry. It is possible that neither the scientific definitions nor the food industry interpretation of consumers' needs actually fit consumers' own perceptions and associations of snacks and snacking behavior.

IV. Research Findings

The relationships between factors influencing snacking and eating frequency and the outcomes related to snacking and eating frequency are complex (Figure 4). Demographics, education, the environment, the media, cognition, and behavior all influence snacking and eating frequency, which may play a role in the development of obesity. Snacking and eating frequency, as well as obesity, are also implicated in weight management, diabetes, and glycemic control.

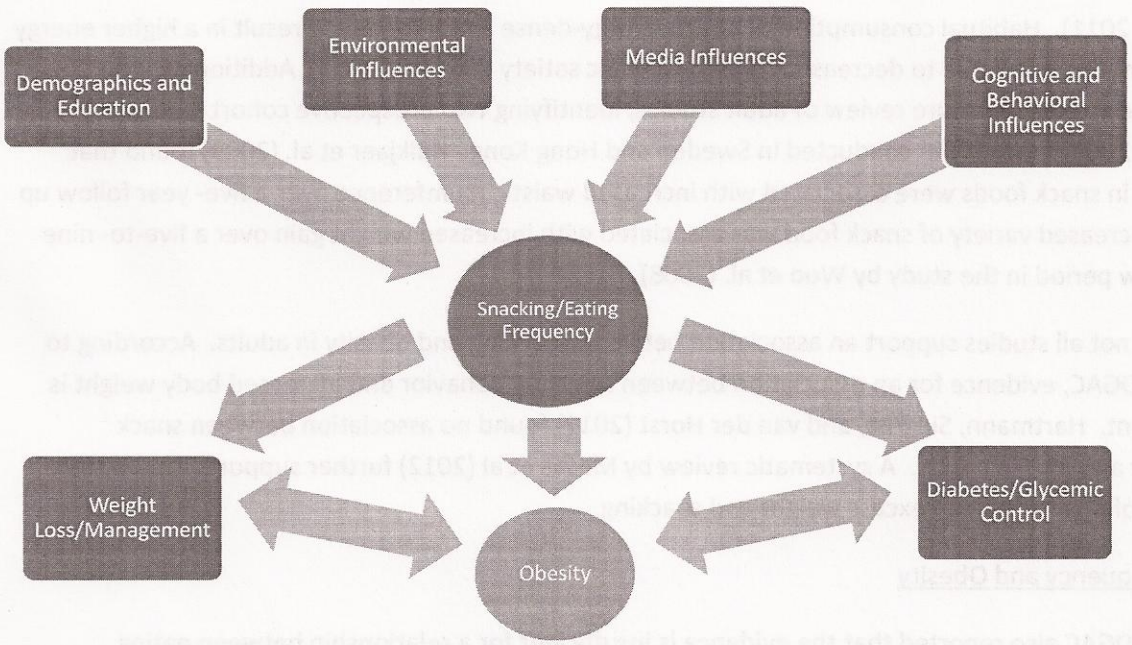

Figure 4. Research on Factors Related to Snacking or Eating Frequency.

Snacking and Obesity

The evidence linking snacking and childhood obesity is conflicting, however new data suggest that there is some correlation between snacking and childhood overweight (Patro B, Szajewska H 2010). Snack frequency was found to be a significant predictor of BMI and BMI changes in Korean children. (Lee et al 2012). The 2010 Dietary Guidelines Advisory Committee (DGAC) conducted a literature review of the research on children and snacking and identified six studies: five cohort studies (Bisset, 2007; Black, 2006; Field, 2004; Francis, 2003; Phillips, 2004) and one case-control study (Novaes, 2008). Two of the studies found a positive relationship between snacking and body weight in children (Bisset, 2007; Novaes, 2008), but two studies found no relationship (Black, 2006; Phillips, 2004). One study initially found a negative relationship between snacking and adiposity in girls, but after adjusting for potential confounders the relationship was no longer significant (Field, 2004). Another found that snacking in front of the television was associated with development of overweight in children (Francis, 2003). One of the reasons for the inconsistency of findings is likely due to the variability in the study designs and definitions for snacking.

In adults, the evidence of an association between snacking and obesity is also conflicting. While several studies indicate that frequent snacking on energy-dense foods without energy compensation can contribute to weight gain, there does not appear to be a correlation between snacking frequency and BMI. However, several studies have reported a positive association between snacking and obesity. McCrory and Campbell (2011) found that regardless of snack macronutrient composition, snack consumption is associated with overeating and weight gain, likely from failure to compensate for energy intake, which is not typically compensated for at the next meal, leading to a positive energy balance

(Chapelot 2011). Habitual consumption of a high energy-dense snack food may result in a higher energy intake from the snack due to decreased sensory-specific satiety (Tey et al 2012). Additionally, the 2010 DGAC conducted a literature review of adult studies, identifying two prospective cohort studies (Halkjaer, 2009; Woo, 2008) conducted in Sweden and Hong Kong. Halkjaer et al. (2009) found that diets high in snack foods were associated with increased waist circumference over a five- year follow up period. Increased variety of snack food was associated with increased weight gain over a five-to- nine year follow period in the study by Woo et al. (2008).

However, not all studies support an association between snacking and obesity in adults. According to the 2010 DGAC, evidence for an association between snacking behavior and increased body weight is inconsistent. Hartmann, Siegrist, and van der Horst (2012) found no association between snack frequency and BMI in adults. A systematic review by Mesas et al (2012) further supports inconsistent evidence of a link between excess weight and snacking.

Eating Frequency and Obesity

The 2010 DGAC also reported that the evidence is insufficient for a relationship between eating frequency and overweight/obesity in children and adults (Part D, Section 1: Energy Balance, p.18). The literature review identified one prospective cohort study with adults (van der Heijden, 2007), which investigated the association between food patterns and long-term weight gain in US men over a 10 year period. An increased number of eating occasions above the three standard meals daily was associated with a higher risk of 5 kg weight gain over time. The Committee did not review the literature on the usefulness of reducing eating frequency for adults actively losing weight.

For children and adolescents, especially females, the effects of snacking are even less clear. The 2010 DGAC literature review identified one prospective cohort study (Franko, 2008) conducted in the US with a sample of 2,379 girls. Franko (2008) found that increased meal frequency, measured by number of days with more than three meals, was inversely associated with BMI in adolescent girls. Conversely, Ritchie (2012) observed that a lower eating frequency predicts a greater gain in adiposity in adolescent females. The results of additional studies on adolescents and children provide evidence that increased meal frequency may be inversely related to childhood and adolescent obesity, especially in the 3-5 meal range, and that increased meal frequency may help reduce BMI in adolescents (Koletzko and Toschke 2010; Mota et al 2008; Jääskeläinen et al 2012; Antonogeorgos et al 2012). Energy density as well as eating frequency has been implicated in childhood weight gain from increased calorie intake. It has been estimated that even a small difference in the energy density of snacks consumed by children could translate into an increase in energy intake (Maffeis, 2008). For example, a 5 kJ/g difference in snack energy density could lead to a total difference of 200 kJ per day (47.8 kcal/day) (Maffeis, 2008) (Part D, Section 1: Energy Balance, p.34).

Weight Loss and Management

A different snacking and eating pattern may need to be required for individuals actively trying to lose or maintain their weight. Although there appears to be a trend toward recommending fewer, smaller meals and snacks, there is still no consensus on the role of snacking and meal frequency in weight

management. Proponents for small, frequent meals and snacks believe that this pattern aids in weight loss. According to Bachman et al (2011), three meals and two snacks per day may be beneficial for maintaining weight loss. It has also been observed that the three- meals- per -day pattern may help sustain satiety during the day and fat oxidation at night in healthy, normal-weight women compared to eating fewer meals per day (Smeets and Westerterp-Plantenga 2008). And the opposite may be true. Eating less than three times per day may negatively impact appetite control by increasing perceived appetite and reducing perceived satiety (Leidy and Campbell 2011) and contribute to weight gain. Some types of snacks may be more beneficial than others for weight loss and weight management because of their effect on satiety. Chapelot (2011) observed that while snacks in general have been shown to have a weak satiety effect, snacks higher in protein having the strongest effect.

Alternatively, other research has found a either a negative or no association between consumption patterns and weight loss and maintenance. One systematic review found inconsistent evidence of a link between excess weight and daily eating frequency and irregular meals (Mesas et al 2012). A "nibbling" eating pattern (defined as "eating in an unplanned and repetitious manner between meals and snacks without an accompanying sense of loss of control" by the Eating Disorder Examination) did not appear to have significant consequences for BMI, the overall pattern of eating, shape or weight concerns, or for any measured pathological eating behaviors in university women (Reas et al 2011). Thus, increasing meal frequency may not lead to significant body weight loss, reduced energy intake, or lower BMI for those intending to lose weight, although it may reduce perceived hunger (Cameron, Cyr, Doucet 2010; Bachman and Raynor 2012).

Diabetes and Glycemic Control

With the increasing prevalence of diabetes, research has begun to focus on the effect eating patterns may have on glucose and insulin responses. A study by Carlson et al (2007) found that eating a single, large meal may lead to elevated fasting glucose levels and impaired morning glucose tolerance associated with a delayed insulin response. However, the participants' overall impaired glucose tolerance was reversible after 2 months. A "nibbling" meal pattern has been associated with increased serum glucose and decreased serum insulin and may have metabolic benefits for obese individuals (Rashidi, Mahboob, Sattarivand 2003). The supportive evidence for the health benefits of eating breakfast is strong across populations, so it is no surprise that a positive association has been found between skipping breakfast and type 2 diabetes. Mekary et al (2012) observed a 21% increase in type 2 diabetes in men who did not eat breakfast. They noted that consuming fewer meals (1-2 per day versus 3) is also associated with an increased risk of type 2 diabetes in men. However, a direct link between snacking between meals and type 2 diabetes risk was mediated by BMI (Mekary et al 2012).

Factors Influencing Consumption

Demographics and Education

Snacking research has also focused on the factors that influence snack choices and consumption patterns. Gender differences pertaining to snacking have been noted in several studies. Women appear more likely to consume healthier snacks such as fruits, while men more often choose unhealthful foods,

such as sweets and savories (Hartmann, Siegrist, van der Horst 2012). In the UK, women are more likely to snack from multiple product categories (especially chocolate, vegetables, and dairy), while men were the greater consumers of toast, burgers, and kebabs (IGD Fact Sheet on Healthy Snacking 2006). Based on this research, women appear to be more conscious of the healthfulness of their snack decisions and more likely to try a variety of options. Knowledge and education also impact snack choices. According to Nasser et al (2011), consumers have limited knowledge of unhealthful ingredients, such as *trans*-fats, in snacks and many do not take them into consideration when choosing snacks.

Environment

An individual's environment also affects their snack choices and consumption patterns. The food and beverage shopping environment dictates what types of snacks are available, their visibility to the consumer, and point-of-purchase decisions. Corner stores are generally considered to lack healthy options. In an analysis of Philadelphia corner stores by Lucan, Karpyn, and Sherman (2007), 80.0-91.5% of snack foods were "unhealthy" by school nutrition standards, including 7 of 11 wholegrain products. Only 3.6% of products were liberally classified as whole grain and there were no fruit or vegetable snacks. They found that a single snack item could supply 6-14% of a day's recommended calories, fat, sugar, and sodium on average (or 56-169% at the extreme) for a "typical" child (Lucan, Karpyn, and Sherman 2007). In addition to the types of snacks available, the location of products on the store shelves also impacts snack choices. Shelf space availability for energy-dense snack foods is positively linked with BMI (Rose et al 2010).

Changing work schedules have impacted Americans' eating habits, as described previously. Studies show an increase in snacking among night shift workers, which may result from unavailability of preferred foods in the workplace, a lack of time, and a reduced desire to eat at night (Atkinson et al 2008). Environmental cues are a strong predictor of consumption patterns. One study of undergraduates found they were more likely to eat foods when they were exposed to meal cues and less likely to eat them with snack cues, and were more likely to eat ambiguous foods when they perceived them as a meal rather than a snack, and only likely to display an effect of environmental cues on intake when hungry (Shimizu, Payne, and Wansink 2010). Young women appear susceptible to social and environmental cues during a consumption occasion. The presence of other individuals, as well as portion size, has been shown to affect how much young women eat during an eating occasion (Hermans et al 2012). Time of day also influences snack intake. Lastly, a consumer research study demonstrated an increase in in-home morning snacking, which has shown the strongest growth in recent years compared to evening and afternoon snacking (NPD Group Snacking in America report 2012).

Media

An interesting study by Beaudoin and Hong (2011) examined the characteristics of people seeking health information from various media sources (newspapers, television, and the Internet). They found that among people seeking health information from newspapers, increases in income and white ethnicity were associated with unhealthful snacking. People who sought health information from television were more likely to consume sugar-sweetened beverages. Within this group, whites and those having a

higher income were more likely to consume unhealthful snacks, with inverse associations in non-whites and lower income individuals. However, they discovered an insignificant association of lifestyle behaviors with unhealthful snacking among people who sought health information via the Internet.

Cognition and Behavior

It is no surprise that in a chronically stressed society, anxiety and psychosocial stress have been linked to increased snack intake and eating frequency, respectively (Schneider et al 2012; Jahns 2007). Motivation and self-control also factor into our consumption patterns. In one study, BMI was found to be positively correlated with the motivation to obtain energy-dense snack foods (Goldfield, Lumb, Colapinto 2011). Yet, this association should be interpreted with caution, because we do not know if overweight or obesity is the cause or the result of motivation to obtain energy-dense snack foods. Pharmacological or behavioral interventions may help reduce the rewarding value of energy-dense snacks or increase the rewarding value of fruits and vegetables, but may not necessarily translate to a decreased risk of obesity. The ability to maintain self-control also influences snacking behaviors, but one study suggests that exercising self-control in a particular situation may be dependent on attitudes. Weak self-control appears to make individuals vulnerable to impulsive tendencies (such as unhealthful snacking). However, strong self-control does not necessarily lead to less unhealthy snacking, but since impulsive tendencies are low, the behavior depends more on an individual's positive or negative attitude toward unhealthy snacking (Honkanen et al 2012).

Even the timing of consumption occasions can affect intake behavior and metabolism. Recent food addiction research shows that constant access to palatable food can influence daily feeding/fasting rhythms, leading to changes in the alternation of metabolic states that stimulate a time-oriented expectation, demand, and seeking behavior for those foods (Escobar et al 2011). Thus, continual consumption of palatable foods can trigger the motivation to consume those foods during certain times of the day. Escobar et al (2011) investigate the impact of shifted feeding schedules on consumption patterns, where the timing pattern of consumption occasions began later in the day instead of earlier in the day. According to the researchers, if scheduled feeding can lead to food addiction, then shifted feeding schedules toward the sleep phase can result in altered ingestive behavior, obesity and disturbed metabolic responses (Escobar et al 2011).

Research has also shown that our perceptions and memories of foods can impact future eating occasions with those foods. According to Higgs (2008), memory for the specific attributes of foods eaten in the recent past and for the predicted consequences of eating acquired over repeated experiences influence food intake. Consumer research also indicates that the type of food may also influence expected satiety. Bilman et al (2010) found that products perceived as fat, high in protein, with a savory taste and in one piece are expected to have a higher level of satiety compared to sweet products and products that exist of multiple small items.

Furthermore, expected satiation may contribute to regulation of portion size in self-selected meals and may be influenced by food familiarity (learned associations), size, and volume (Brunstrom 2011). Although it has not yet been formally tested, the expected satiety drift hypothesis suggests that shifts in

expected satiation are much more likely to occur in one direction (expected satiation will tend to increase). Introducing foods of lower energy density after exposure to a version with a higher energy density may increase the satiating power of the low energy-density food. This may be an opportunity to increase consumption of more healthful foods and decrease caloric intake.

Market research firms have also explored other consumer behaviors around snacking. When asked to state their reasons for snacking, half of consumers reported that being hungry was the main reason, followed by missing a meal (23%), wanting a treat (25%), and being bored (22%) (IGD Fact Sheet Healthy Snacking 2006) (Figure 5). Multiple studies have shown that taste is the primary driver of snack selection, but nutrition/ healthfulness, cost, and time are also reported to be important factors (IDG Fact Sheet Healthy Snacking 2006; NPD Snacking in America report 2012). Other research has focused on more on the types of snacks chosen. The purchase of healthy snacks is most often driven by good nutritional value (58%), preparation method (38%), and portion control (20%) (IGD Fact Sheet Healthy Snacking 2006) (Figure 6).

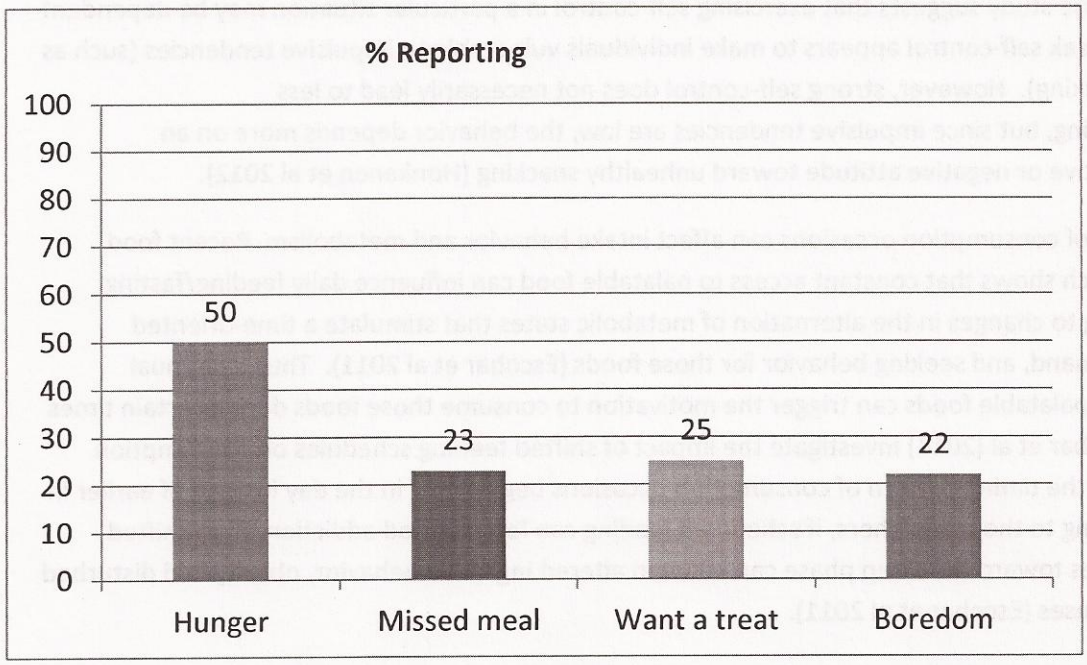

Figure 5. Reasons for Snacking. Source: IGD Fact Sheet on Healthy Snacking (2006).

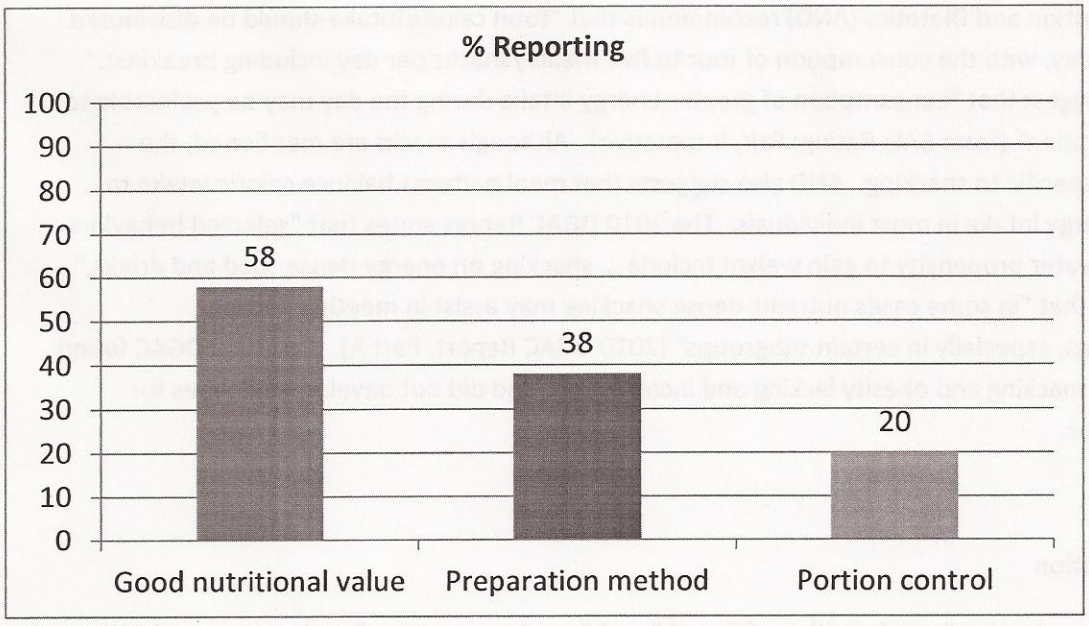

Figure 6. Drivers for Purchase of Healthy Snacks. Source: IGD Fact Sheet on Healthy Snacking (2006).

Research on behavioral and cognitive factors influencing snacking varies widely and covers many facets of human behavior and cognition. Although consumer research studies related to snacking exist, none have focused on consumer perceptions and attitudes around consumption occasions, including their associations with eating occasion terminology. More research is needed to determine the best way to apply these findings to implement behavior change.

Limitations to the Research

Several limitations should be considered when evaluating existing snacking research. First, many studies rely on self-reported data from participants. McCrory and Campbell (2011) observed that frequent underreporting of energy intake is linked to underreporting of snack intake. Such underreporting may attenuate a potential association. Additionally, the population studied should be carefully considered. Different populations require different energy needs and have their own well established intake patterns. Study results may be specific to groups such as the elderly, athletes, diabetics, and those actively trying to lose weight, and may not be generalizable to the population as a whole.

Translating Research into Practice

There is confusion about what constitutes a "snack," what types of snacks should be eaten, and how often or when to eat them. Consumers obtain the majority of their health and nutrition information from the Internet, TV, and magazines (AND 2011), but these sources do not always provide credible, science-based information. Although consumers consult health care providers and dietitians less frequently (AND 2011), these professionals need to be equipped with the most up-to-date information and consumer-friendly resources about food and beverage consumption. Currently, there are no specific evidenced-based guidelines or recommendations for snacking in the general population. The

Academy of Nutrition and Dietetics (AND) recommends that "total caloric intake should be distributed throughout the day, with the consumption of four to five meals /snacks per day including breakfast." They go on to suggest that "consumption of greater energy intake during the day may be preferable to evening consumption" (from EAL; Rating: Fair, Imperative). Although snacks are mentioned, the guideline is not specific to snacking. AND also suggests that meal patterns balance caloric intake to avoid excess energy intake in most individuals. The 2010 DGAC Report states that "selected behaviors that lead to a greater propensity to gain weight include ... snacking on energy-dense food and drinks," yet it also notes that "in some cases nutrient-dense snacking may assist in meeting nutrient recommendations, especially in certain subgroups" (2010 DGAC Report, Part A). The 2010 DGAC found the research on snacking and obesity lacking and inconsistent, and did not develop guidelines for snacking behavior.

V. The Solution

The lack of a clear, standardized definition of "snack" and "snacking occasion" makes communication about snacking across consumer and stakeholder groups difficult. A successful plan to resolve this problem should focus on results from consumer research and collaborations among stakeholders that lead to universal definitions of consumption occasion terms, thereby improving snacking communications (Figure 7). Before traditional research can be conducted on snacking behavior and meal frequency in relation to body weight, we must develop research definitions for these consumption terms that are consistent across studies. The 2010 DGAC recommends further research on snacking behavior and meal frequency in relation to body weight be performed and that more precise definitions for snacking be developed (Part D, Section 1: Energy Balance, p.60). The first step towards reaching standardized traditional research definitions is to examine how study participants perceive consumption occasion terms. Additional consumer research is needed to identify commonly agreed upon characteristics of snacking from a consumer perspective. This will aid understanding of what the majority of people perceive to be a "snack" or "snacking occasion" and shed light on any psychological associations correlated with snacking.

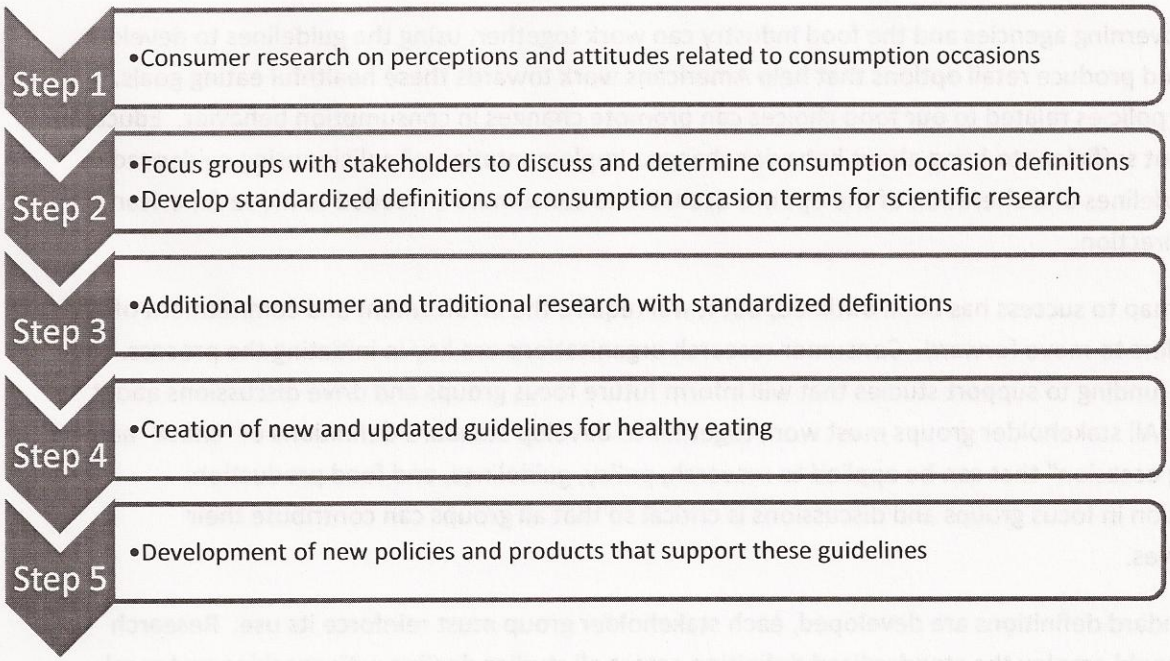

Figure 7. Road Map to Success.

Next, it is imperative that focus groups be created that bring together stakeholders (academics, consumer research groups, governing and professional agencies dealing with health and nutrition issues, and food industries) to discuss and determine agreed upon definitions of "snack" and "snacking occasion." The definitions must be adaptable and sustainable to accommodate changes in American culture that affect snacks and snacking. Several domains may need to be considered when creating a standard definition, including (but not limited to) portion size, timing of the snacking occasion, convenience, and available options. Once standard definitions are developed, additional scientific research can be conducted.

Professional, academic, and government institutions can then develop more effective guidelines for healthy eating. For example, new research employing standard definitions of consumption occasion terms for snacks can influence the DGAs, which provide guidelines for healthful eating in the general population. To influence the 2015 DGAs, research with standardized definitions would need to be shared with the 2015 DGAC by fall of 2014, when their final meetings are held and there is opportunity for public comment ("Dietary Guidelines for Americans, 2015"). Since it may be too soon to have a great impact on the 2015 DGAs, the implementation of standardized definitions would more likely benefit the 2020 DGAs. This opens up an opportunity to apply the latest evidence on snacking as a means of improving the health of Americans. Furthermore, dietary guidelines may be developed for specific groups or populations. As certain chronic diseases become more prevalent in the United States, it may be beneficial to have recommendations for consumption occasions that are disease-specific, such as for diabetes. Upcoming DGAs are planning to include evidence and recommendations for children under 2 (Personal Communication, Marianne Smith-Edge), and this may be another special population where research on snacking would be in high demand. Additional groups that could benefit from snacking research and guidelines include athletes and the increasingly elderly population of baby boomers.

Finally, governing agencies and the food industry can work together, using the guidelines to develop policies and produce retail options that help Americans work towards these healthful eating goals. Changing policies related to our food choices can promote changes in consumption behavior. Education alone is not sufficient to bring about behavior change. Implementation of policies using evidenced-based guidelines and alteration of the options available to consumers is needed to move Americans in a healthy direction.

The roadmap to success has been outlined, but it will require the involvement and commitment of all stakeholders to move forward. Consumer research organizations are key in initiating the process. They will need funding to support studies that will inform future focus groups and drive discussions about snacking. All stakeholder groups must work together to develop standard definitions of "snack" and "snacking occasion" that can be applied to research, policy, guidelines, and food production. Participation in focus groups and discussions is critical so that all groups can contribute their perspectives.

Once standard definitions are developed, each stakeholder group must reinforce its use. Research groups should employ the standardized definition across all studies dealing with snacking and meal frequency. Government, academic, and professional organizations (experts) should evaluate the available research, taking into consideration new research using the newly developed standardized definition and use the new research to inform the development of any new dietary guidelines that involve snacks or snacking

Government agencies and policy makers should consider research as well as guidelines from academic and professional organizations when creating policies that affect consumers and/or the food industry. The research may affect the quality, type, ingredients, portion size, and other aspects of foods marketed as snacks. Last but not least, as the food industry creates new products and modifies existing ones, it must work to accommodate the guidelines and policies developed by government, academic, and professional agencies.

VI. Conclusion

Eating habits in America have changed drastically over the past two centuries. Social and economic changes have stimulated a movement away from a 3-meals-a-day pattern to an eating pattern that includes snacks. The food industry had also played a role by creating products that meet the demands of American consumers. Together, these factors created an increase in snacking in both adults and children, which contributes a significant number of calories to the average American's diet.

A variety of studies exists related to snacks and consumption occasions among Americans. However, they employ varying definitions of "snack" and "snacking occasion", making comparison of results difficult. Thus, the association between snacking and or meal frequency and health outcomes such as obesity, weight loss, weight management or diabetes is unclear. At present, there is no standardized

definition of "snack" or "snacking occasion." A standardized research definition is needed to allow comparison of research findings and to obtain a better understanding of how snacking affects obesity.

The best way to create such a standardized definition is to first conduct consumer research to better understand the characteristics, motivations, and other factors associated with snacking. Focus groups bringing together stakeholders from academics, consumer research groups, governing and professional agencies and food industries will facilitate discussion of the results of consumer research studies and ultimately produce standard definitions that all groups can agree upon. It is crucial that all stakeholders participate in the dialogue and utilize the new definitions when conducting scientific research, creating guidelines and policies, and manufacturing products. The process to arrive at this point will take time and resources, but the outcomes can help consumers make more healthful choices.

VII. References

1. Academy of Nutrition and Dietetics. Nutrition and You: Trends 2011Presentation. Available from: http://www.eatright.org/nutritiontrends/#.UJGM6m9EQjw
2. Academy of Nutrition and Dietetics. Position of the American Dietetic Association: Weight Management. JAND. 2009 Feb;109(2):330-346. Available from: http://www.eatright.org/About/Content.aspx?id=8382
3. Andersson J, Nydahl M, Gustafsson K, Sidenvall B, Fjellström C. Meals and snacks among elderly self-managing and disabled women. Appetite. 2003 Oct;41(2):149-60.
4. Antonogeorgos G, Panagiotakos DB, Papadimitriou A, Priftis KN, Anthracopoulos M, Nicolaidou P. Breakfast consumption and meal frequency interaction with childhood obesity. Pediatr Obes. 2012 Feb;7(1):65-72.
5. Atkinson G, Fullick S, Grindey C, Maclaren D. Exercise, energy balance and the shift worker. Sports Med. 2008;38(8):671-85.
6. Bachman JL, Phelan S, Wing RR, Raynor HA. Eating frequency is higher in weight loss maintainers and normal-weight individuals than in overweight individuals. J Am Diet Assoc. 2011 Nov;111(11):1730-4.
7. Bachman JL, Raynor HA. Effects of manipulating eating frequency during a behavioral weight loss intervention: a pilot randomized controlled trial. Obesity (Silver Spring). 2012 May;20(5):985-92.
8. Beaudoin CE, Hong T. Health information seeking, diet and physical activity: an empirical assessment by medium and critical demographics. Int J Med Inform. 2011 Aug;80(8):586-95.
9. Bilman EM, van Trijp JC, Renes RJ. Consumer perceptions of satiety-related snack food decision making. Appetite. 2010 Dec;55(3):639-47.
10. Brunstrom JM. The control of meal size in human subjects: a role for expected satiety, expected satiation and premeal planning. Proc Nutr Soc. 2011 May;70(2):155-61.
11. Cameron JD, Cyr MJ, Doucet E. Increased meal frequency does not promote greater weight loss in subjects who were prescribed an 8-week equi-energetic energy-restricted diet. Br J Nutr. 2010 Apr;103(8):1098-101.
12. Carlson O, Martin B, Stote KS, Golden E, Maudsley S, Najjar SS, Ferrucci L, Ingram DK, Longo DL, Rumpler WV, Baer DJ, Egan J, Mattson MP. Impact of reduced meal frequency without caloric restriction on glucose regulation in healthy, normal-weight middle-aged men and women. Metabolism. 2007 Dec;56(12):1729-34.
13. Chapelot D. The role of snacking in energy balance: a biobehavioral approach. J Nutr. 2011 Jan;141(1):158-62.
14. "Chapter 2: Profiling Food Consumption in America." Agricultural Fact Book 2001-2002. USDA. Available from: http://www.usda.gov/factbook/chapter2.pdf.
15. "Consumer Trends: Salty Snack food in the United States." Agriculture and Agri-Food Canada. Apr 2011. Available from: http://www.gov.mb.ca/agriculture/statistics/agri-food/us_snack_food_consumer_trends_en.pdf

16. "Dietary Guidelines for Americans, 2015." US Department of Health and Human Services. 2012. Available from: http://health.gov/dietaryguidelines/2015.asp#meetings
17. Duffey KJ, Popkin BM. Energy density, portion size, and eating occasions: contributions to increased energy intake in the United States, 1977-2006. PLoS Med. 2011 Jun;8(6):e1001050.
18. Escobar C, Salgado R, Rodriguez K, Blancas Vázquez AS, Angeles-Castellanos M, Buijs RM. Scheduled meals and scheduled palatable snacks synchronize circadian rhythms: consequences for ingestive behavior. Physiol Behav. 2011 Sep 26;104(4):555-61.
19. Fjellstrom C. Mealtime and meal patterns from a cultural perspective. Scandinavian J Nutr. 2004; 48(4):161-164.
20. Food & Health Surveys, 2006-2012. International Food Information Council. Available from: http://www.foodinsight.org/Resources/Survey-Research.aspx
21. "Potato Chips, Corn Chips, and Similar Snacks." Gale Business Resources. 2002. Gale Group, Oct 1, 2002. Summary available from http://business.highbeam.com/industry-reports/food/potato-chips-corn-chips-similar-snacks.
22. Gregori D and Maffeis C. Snacking and obesity: urgency of a definition to explore such a relationship (letter to the editor). J Am Diet Assoc. 2007 Apr;107(4):562; discussion 562-3.
23. Goldfield GS, Lumb AB, Colapinto CK. Relative reinforcing value of energy-dense snack foods in overweight and obese adults. Can J Diet Pract Res. 2011 Winter;72(4):170-4.
24. Hartmann C, Siegrist M, van der Horst K. Snack frequency: associations with healthy and unhealthy food choices. Public Health Nutr. 2012 Aug 16:1-10
25. Healthy Snacking. IGD Group. 2006 Aug 15. Available from: http://www.igd.com/index.asp?id=1&fid=1&sid=17&tid=0&folid=0&cid=96
26. Hermans RC, Larsen JK, Herman CP, Engels RC. How much should I eat? Situational norms affect young women's food intake during meal time. Br J Nutr. 2012 Feb;107(4):588-94.
27. Ament P. "History of Food and Drink." Troy MI copyright 1997-2007. The Great Idea Forum. Accessed 18 Sept 2012. Available from: http://www.ideafinder.com/history/category/snackfood.htm
28. Honkanen P, Olsen SO, Verplanken B, Tuu HH. Reflective and impulsive influences on unhealthy snacking. The moderating effects of food related self-control. Appetite. 2012 Apr;58(2):616-22.
29. Jääskeläinen A, Schwab U, Kolehmainen M, Pirkola J, Järvelin MR, Laitinen J. Associations of meal frequency and breakfast with obesity and metabolic syndrome traits in adolescents of Northern Finland Birth Cohort 1986. Nutr Metab Cardiovasc Dis. 2012 Aug 14.
30. Jahns L. Snacking and obesity: urgency of a definition to explore such a relationship (response to Gregori and Maffeis). J Am Diet Assoc. 2007 Apr;107(4):562; discussion 562-3.
31. Johnson GH, Anderson GH. Snacking definitions: impact on interpretation of the literature and dietary recommendations. Crit Rev Food Sci Nutr. 2010 Oct;50(9):848-71.
32. Koletzko B, Toschke AM. Meal patterns and frequencies: do they affect body weight in children and adolescents? Crit Rev Food Sci Nutr. 2010 Feb;50(2):100-5.

33. Lee HH, Park HA, Kang JH, Cho YG, Park JK, Lee R, Yoon JY, Kim OH. Factors related to body mass index and body mass index change in korean children: preliminary results from the obesity and metabolic disorders cohort in childhood. Korean J Fam Med. 2012 May;33(3):134-43.
34. Leidy HJ and Campbell WW. The effect of eating frequency on appetite control and food intake: Brief synopsis of controlled feeding studies. J Nutr. 2011 Jan;141(1):154-7.
35. Lennernas M, Andersson I. Foodbased classification of eating episodes (FBCE). Appetite. 1999;32:53-65
36. Lucan SC, Karpyn A, Sherman S. Storing empty calories and chronic disease risk: snack-food products, nutritive content, and manufacturers in Philadelphia corner stores. J Urban Health. 2010 May;87(3):394-409.
37. McCarthy J . "Chapter 2: The Snack Industry: History, Domestic, and Global Status." In Snack Foods Processing. Lusas, EW and Rooney LW (eds). CRC Press, 2001. http://books.google.com/books?id=W_5wlzckPkMC&printsec=frontcover#v=onepage&q&f=false
38. McCrory and Campbell. Effects of Eating Frequency, Snacking, and Breakfast Skipping on Energy Regulation: Symposium Overview. J. Nutr. 2011 Jan;141(1):144-147.
39. Mekary RA, Giovannucci E, Willett WC, van Dam RM, Hu FB. Eating patterns and type 2 diabetes risk in men: breakfast omission, eating frequency, and snacking. Am J Clin Nutr. 2012 May;95(5):1182-9.
40. Mesas AE, Muñoz-Pareja M, López-García E, Rodríguez-Artalejo F. Selected eating behaviours and excess body weight: a systematic review. Obes Rev. 2012 Feb;13(2):106-35
41. Mota J, Fidalgo F, Silva R, Ribeiro JC, Santos R, Carvalho J, Santos MP. Ann Hum Biol. Relationships between physical activity, obesity and meal frequency in adolescents. 2008 Jan-Feb;35(1):1-10.
42. Nasser R, Cook S, Bashutski M, Hill K, Norton D, Coleman J, Walker S, Charlebois S. Consumer perceptions of trans fats in 2009 show awareness of negative effects but limited concern regarding use in snack foods. Appl Physiol Nutr Metab. 2011 Aug;36(4):526-32.
43. "Nutrition Policy Profiles: Nutrition Labeling Regulation." The Prevention Institute. May 2002. Available from: http://thrive.preventioninstitute.org/CHI_labeling.html
44. Olver L. 2000. "Meal Times. " The Food Timeline. Last updated 2 September 2012. Available from: http://www.foodtimeline.org/foodfaq7.html
45. Patro B, Szajewska H. Meal patterns and childhood obesity. Curr Opin Clin Nutr Metab Care. 2010 May;13(3):300-4.
46. Piernas C, Popkin BM. Trends in snacking among U.S. children. Health Aff (Millwood). 2010 Mar-Apr;29(3):398-404.
47. Rashidi MR, Mahboob S, Sattarivand R. Saudi Med J. Effects of nibbling and gorging on lipid profiles, blood glucose and insulin levels in healthy subjects. 2003 Sep;24(9):945-8.
48. Reas DL, Wisting L, Kapstad H, Lask B. Nibbling: frequency and relationship to BMI, pattern of eating, and shape, weight, and eating concerns among university women. Eat Behav. 2012 Jan;13(1):65-6.
49. Report of the DGAC on the Dietary Guidelines for Americans, 2010. Part A: Executive Summary. Available from:

http://www.cnpp.usda.gov/Publications/DietaryGuidelines/2010/DGAC/Report/A-ExecSummary.pdf

50. Report of the DGAC on the Dietary Guidelines for Americans, 2010. Part D. Section 1: Energy Balance and Weight Management. Available from: http://www.cnpp.usda.gov/Publications/DietaryGuidelines/2010/DGAC/Report/D-1-EnergyBalance.pdf
51. Ritchie LD. Less frequent eating predicts greater BMI and waist circumference in female adolescents. Am J Clin Nutr. 2012 Feb; 95(2): 290-6.
52. Rodríguez G, Moreno LA. Is dietary intake able to explain differences in body fatness in children and adolescents? Nutr Metab Cardiovasc Dis. 2006 May;16(4):294-301.
53. Rose D, Bodor JN, Hutchinson PL, Swalm CM. The importance of a multi-dimensional approach for studying the links between food access and consumption. J Nutr. 2010 Jun;140(6):1170-4.
54. Schneider KL, Panza E, Appelhans BM, Whited MC, Oleski JL, Pagoto SL.The emotional eating scale. Can a self-report measure predict observed emotional eating? Appetite. 2012 Apr;58(2):563-6.
55. Sebastian RS, Wilkinson Enns C, Goldman JD. Snacking Patterns of U.S. Adults: What We Eat In America, NHANES 2007-2008. Food Surveys Research Group Dietary Data Brief No. 4. June 2011. Available from: http://ars.usda.gov/Services/docs.htm?docid=19476.
56. Sebastian RS, Goldman JD, Wilkinson Enns C. Snacking Patterns of U.S. Adolescents: What We Eat In America, NHANES 2005-2006. Food Surveys Research Group Dietary Data Brief No. 2. September 2010. Available from: http://ars.usda.gov/Services/docs.htm?docid=19476.
57. Shimizu M, Payne CR, Wansink B. When snacks become meals: How hunger and environmental cues bias food intake. Int J Behav Nutr Phys Act. 2010 Aug 25;7:63.
58. Smeets AJ, Westerterp-Plantenga MS. Acute effects on metabolism and appetite profile of one meal difference in the lower range of meal frequency. Br J Nutr. 2008 Jun;99(6):1316-21.
59. Snacking in America: The changing role of snack foods in America - Report Excerpts. NPD Group. 2012. Available from: https://www.npd.com/lps/pdf/The_NPD_Groups_Snacking_in_America-Report_Excerpts.pdf
60. Tey SL, Brown RC, Gray AR, Chisholm AW, Delahunty CM. Long-term consumption of high energy-dense snack foods on sensory-specific satiety and intake. Am J Clin Nutr. 2012 May;95(5):1038-47.